

FORM PTO-1300 (REV. 12-2001)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER 03251.00018	
INTERNATIONAL APPLICATION NO. PCT/US00/27198	INTERNATIONAL FILING DATE 03 October 2000	PRIORITY DATE CLAIMED 05 October 1999	
TITLE OF INVENTION INJECTION MOLDING TECHNIQUES UTILIZING INTERLOCKING KNIT LINES			
APPLICANT(S) FOR DO/EO/US PORTER, MARSHALL R.			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.</li> <li><input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).</li> <li><input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))           <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li><input type="checkbox"/> has been communicated by the International Bureau.</li> <li><input checked="" type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).           <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto.</li> <li><input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li><input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))           <ol style="list-style-type: none"> <li><input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li><input type="checkbox"/> have been communicated by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li><input type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li><input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li><input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol>			
Items 11 to 20 below concern document(s) or information included:			
<ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li><input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li><input type="checkbox"/> A <b>FIRST</b> preliminary amendment.</li> <li><input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.</li> <li><input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</li> <li><input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</li> <li><input checked="" type="checkbox"/> Other items or information:  <b>Written Opinion &amp; Reply</b>  <b>International Preliminary Examination Report</b>  <b>International Publication WO 01/24986</b>  <b>Forms PCT/IB/301 - 304 - 308</b> </li> </ol>			

21.  The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

Neither international preliminary examination fee (37 CFR 1.482)  
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO  
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Total claims	14 - 20 =	0	x \$18.00	\$ 0.00
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<b>MULTIPLE DEPENDENT CLAIM(S) (if applicable)</b>				+ \$280.00

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Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above  
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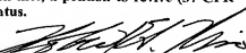
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SEND ALL CORRESPONDENCE TO:

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REGISTRATION NUMBER

Ree'd PTO 0 2 APR 2002

**INJECTION MOLDING TECHNIQUES  
UTILIZING INTERLOCKING KNIT LINES**

5

**Background of the Invention**

The present invention relates to molding processes and apparatus. Specifically, the present invention relates to injection molding processes and apparatus which provide for increased strength of knit lines formed during the molding process.

10 Injection molding typically involves multiple flow fronts within the mold. Flow fronts are the leading interface of a resin stream flowing within the mold. These multiple flow fronts may derive from multiple gates in the mold or from multiple flow paths communicating from a single gate. As the molding process takes place, the flow fronts eventually meet one another, 15 resulting in the formation of one or more knit lines.

In the prior art, knit lines represent areas of decreased strength within the molded article. This is usually undesirable because such areas represent material weakness in the molded article. Such weakness is especially apparent in molded articles that include fiber reinforcement since fiber materials typically 20 do not become oriented or meshed across knit lines. Accordingly, it is a primary objective of the invention to provide molding processes and apparatus for increasing the strength of knit lines formed during injection molding processes.

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**Summary of the Invention**

A primary aspect of the invention provides for the "handshaking" or intermixing of flow fronts to form interlocking knit lines. Various implements are contemplated to provide for the flow front "handshaking." One method involves modifications in the mold wall geometry to impart rotational or 30 transverse flow to fusing or colliding resin streams. This may result in a "swirling" effect, to provide for the commingling or intermixing of the resin

streams, resulting in an interlocking knit line geometry having increased strength.

The invention also contemplates the use of insert molded or removable implements within the mold cavity to facilitate the flow front "handshaking." For example, an insert molded paddle may be incorporated into the mold at a predetermined and desired location of knit line formation and rotated during the molding process in order to facilitate or improve the handshaking between resin streams. The paddle may be left in the mold cavity to provide increased strength across the knit line. Similarly, directional vanes or directional dams may be insert molded into the mold to provide for flow front handshaking. As an alternative to leaving the paddles, vanes or dams within the molded article, these implements may be temporarily inserted into the mold cavity to induce "handshaking" and then removed before the resin cures. The invention further contemplates modifications to process timing, possibly in conjunction with the above-described insert molded implements, to facilitate the flow front handshake at a predetermined location in the molded article geometry.

In one of its broadest applications, the invention provides an apparatus for injection molding articles, the apparatus comprising a mold cavity for containing an injected volume of resin provided as first and second resin streams, each having a flow front, and means for causing interaction between the flow fronts to form an interlocking knit line geometry. In a particular application, the means for causing interaction between flow fronts may comprise an insert molded implement, such as a paddle, dam or vane. In another particular application, the means for causing interaction between flow fronts may comprise an insert molded implement, such as a paddle, dam or vane, in combination with process timing means for causing the collision of the flow fronts at a predetermined place in the mold.

In another of its broadest applications, the invention also provides a process for injection molding articles, the process comprising the steps of: a) providing a mold defining a mold cavity; b) providing first and second resin

streams within the mold cavity, each resin stream having a flow front; c) causing the flow fronts to interact to form an interlocking knit line geometry.

One advantage provided by the invention is increased strength of molded articles in the local area of the knit line formation. Thus, articles molded according to the invention will typically have greater strength and structural integrity than articles molded according to conventional techniques. Moreover, articles which require increased strength and structural integrity, such as structural polymeric articles may now be formed using injection molding techniques.

The invention also provides increased versatility in mold design with respect to fill gate locations. Prior to the invention, the selection of fill gate locations on a mold depended in a large part on the geometry of the molded article. For example, in the prior art, gate locations were selected such that knit lines were formed in an area of a molded article that is least susceptible to failure under mechanical load. Since the present invention provides increased strength in the area of knit lines, the invention permits the formation of knit lines even in areas where failure may be more likely. Thus, gate locations need not be selected to provide for knit line formation in limited locations within the molded article.

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#### Brief Description of the Drawings

The accompanying drawings which are incorporated into and form a part of the specification, illustrate several embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating a preferred embodiment of the invention and are not to be construed as limiting the invention. In the drawings, in which like numbers refer to like parts throughout:

FIGURES 1 and 2 are sectional views of a mold and molding process according to the prior art;

30 FIGURE 3 is a sectional view of a mold wall geometry and molding process according to a preferred embodiment of the invention;

FIGURE 4 is a sectional view of a mold, insert molded paddle and molding process according to another preferred embodiment of the present invention;

5 FIGURE 5 is a sectional view of a mold, insert molded vane and molding process according to another preferred embodiment of the present invention; and

10 FIGURE 6 is a sectional view of a mold, insert molded dam and molding process according to another preferred embodiment of the present invention.

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#### Description of the Preferred Embodiments

Referring to FIGURES 1 and 2, an injection mold and associated molding process of the prior art involve a mold 10, defining a mold cavity 12 for receiving a volume of resin 14 therein. Resin 14 is provided via a first resin stream 16, having a first flow front 18, and a second resin stream 20 having a second flow front 22. As will be apparent to those of ordinary skill, resin streams 16 and 20 originate from one or more mold gates (not shown) which permit the ingress of resin 14 to mold cavity 12 from an external resin source (not shown). As indicated by the arrows (A), the flow fronts 18 and 22 approach one another during the molding process and fuse or collide to form a knit line 24 as shown in FIGURE 2. According to prior art techniques, the knit line is typically of a generally planar shape, as shown. Moreover, fibers 26, which are generally oriented longitudinally within the resin streams, tend to become re-oriented in a transverse direction near the knit line so as not to extend across the knit line, thereby forming a weakened area within the article.

20 The molding process described in this paragraph is well known in the art.

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Turning now to the preferred embodiments of the present invention, a mold and associated process for molding according to the invention are illustrated in FIGURE 3. Mold 310 defines a mold cavity 312 for receiving a 30 volume of resin in resin streams 316A and 316B. As shown, a means for causing interaction between the flow fronts to form an interlocking knit line

geometry is provided in the form of recesses 311A and 311B formed in the walls 313A and 313B of the mold 310. In this particular embodiment, recess 311A is formed from a first wall 315A extending at roughly a 135-degree angle to the mold wall 313A, a second wall 317A extending roughly parallel to the mold wall 313A and a third wall 319A extending roughly perpendicular to the mold wall 313A. Recess 311B is formed with similar geometry by walls 315B, 317B and 319B.

Both recesses 311A and 311B operate to redirect at least a portion of the respective resin streams 316A and 316B to flow at least partially adjacent one another. As the resin streams 316A and 316B encounter the third walls 319A and 319B, their flow is redirected in a direction, indicated by arrow (T) that is somewhat transverse to the flow path direction, indicated by arrow (F) within the mold cavity. As a result of this redirection, the resin streams are caused to commingle or "handshake", thereby resulting in the formation of an interlocking knit line 320 when the resin cures. As will be appreciated, the interface between the interlocked portions of the molded article represented by the resin streams is stronger than was provided by molding techniques according to the prior art. For example, the molded article will be capable of withstanding higher tensile forces by virtue of the interlocking nature of the knit line 320. Additionally, the orientation of the fibers 326 is redirected in the area of the knit lines and, although not apparent from the illustration, some fibers may extend across the knit line 320 to increase the article strength locally.

Referring now to FIGURE 4, in accordance with another aspect of the invention, an insert molded paddle 430 is provided within the mold cavity 412. Insert molding of paddle 430 may occur according to known general insert molding techniques. Paddle 430 is provided with a number, in this case three, vanes 432 and is mounted within mold cavity 412 so as to permit rotational movement in the direction of arrow (R) of the paddle 430 with respect to the mold cavity. According to the invention, motive means (not shown) is provided to impart rotational force to the paddle 430 during the molding process. Although paddle 430 is illustrated in combination with the wall geometry

features described with respect to FIGURE 3, it will be recognized that the wall geometry is not necessary to the implementation of the paddle 430 as a means for causing interaction between the flow fronts to form an interlocking knit line 420. As in the embodiment of FIGURE 3, the fibers 426 are re-oriented in the area of the knit line 420. Additionally, it will be apparent that paddle 430 may be retained within the molded article and therefore provides additional reinforcement across knit line 420. Alternatively, paddle 430 may be removed prior to curing of the resin, but after it has been utilized to redirect the resin streams to form the interlocking knit lines or to eliminate the knit line altogether. As will be apparent to those of ordinary skill, paddle 430 may be made of any suitable material. If removed during the molding process, it would need to be of a suitable strength and durability for re-use.

Referring now to FIGURE 5, another preferred embodiment of a molding apparatus and associated method are illustrated. In this case, a pair of insert molded vanes 550A and 550B are provided within mold cavity 512, in combination with the wall geometries described with respect to FIGURE 3. Vanes 550A and 550B operate to redirect or channel the resin streams 516A and 516B. Vanes 550A and 550B may be provided as removable elements that may be retracted from the mold cavity, using suitable mechanical implements, after the resin streams have been redirected. Alternatively, vanes may be retained in the molded article and formed of a material suitable for bonding with the resin and providing increased strength across the knit line 520.

FIGURE 6 illustrates yet another preferred embodiment of a mold 610 and associated method according to the invention. In this embodiment, directional dams 660A and 660B are provided within the mold cavity 612 to induce the desired flow pattern within the resin streams 616A and 616B. As illustrated, in contrast to the geometry provided by recesses 311A and 311B relative to FIGURE 3, the directional dams 616A and 616B extend into the flow path of the resin streams 616A and 616B. Moreover, each dam is provided with a first surface 618A, 618B which redirects one of the resin streams in a transverse direction and a second surface 620A and 620B which redirects the

other resin stream in a transverse direction. Thus, each dam 616A and 616B encounters and influences both of the resin streams.

In all of the aforedescribed embodiments, the molding process timing must be appropriate for causing the fusion or collision of the resin streams to occur at the location of the means for causing interaction between the flow fronts to form an interlocking knit line geometry. As will be apparent to those of ordinary skill in the art, process timing would involve the flow rates through the gates of the mold corresponding to the resin streams and may also involve adjustments to the flow path length for each of the resin streams. Alternatively, the geometric modifications or insert molded implements may be adapted to an existing mold in which the location of knit line formation is known.

Those of ordinary skill will appreciate that the above described geometries are merely exemplary and are not the only geometries contemplated by the invention. For example, although generally straight or planar surfaces are illustrated, the invention also contemplates the use of curved or contoured surfaces in order to reduce friction or achieve particular flow characteristics in the area of knit line formation.

Likewise, the aspects of the invention relating to the use of insert molded implements, such as the disclosed paddle, vanes or dams are not limited to such embodiments. Other types of implements may be provided to redirect the resin streams. Moreover, although the invention is described in the context of forming an interlocking knit line, if commingling or interaction between the flow fronts is sufficient, the invention may provide for the elimination of knit lines altogether and is thus not limited to processes where knit lines are present in the finished article.

Although the preferred embodiments of this invention have been described hereinabove in some detail, it should be appreciated that a variety of embodiments will be readily available to persons utilizing the invention for a specific end use. The description of this invention is not intended to be limiting on this invention, but is merely illustrative of the preferred embodiment of this invention. Other products, apparatus and methods which incorporate

modifications or changes to that which has been described herein are equally included within this application. Additional objects, features and advantages of the present invention will become apparent by referring to the above description of the invention in connection with the accompanying drawings.

5

What is claimed is:

**CLAIMS**

1. A process for molding articles, the process comprising the steps of:
  - 5        a) providing a mold defining a mold cavity;
  - b) providing first and second resin streams within the mold cavity, each resin stream having a flow front; and
  - c) causing the flow fronts to interact to form an interlocking knit line geometry.
- 10      2. The process of claim 1 wherein the mold cavity is modified to impart at least one of: rotational and transverse flow to colliding resin streams.
3. The process of claim 1 wherein causing the flow fronts to interact includes inserting at least one implement within the mold cavity to facilitate interaction of the flow fronts.
- 15      4. The process of claim 3 wherein the at least one implement is one of: a molded paddle, directional vane and a directional dam.
5. The process of claim 4 wherein the at least one implement is incorporated into the mold at a predetermined, desired location of knit line formation.
- 20      6. The process of claim 4 further including, where the at least one implement is the molded paddle, rotating the molded paddle during the molding process to facilitate interaction of the flow fronts of the resin streams and retracting the molded paddle from the mold cavity before molding is completed.
- 25      7. The process of claim 4 further including, where the at least one implement is the molded paddle, rotating the molded paddle during the molding process to facilitate interaction of the flow fronts of the resin streams, retaining the molded paddle in the molded article, and bonding the molded paddle with the resin to provide increased strength.
- 30      8. An apparatus for injection molding articles comprising:

a mold cavity for containing an injected volume of resin provided as first and second resin streams, each having a flow front; and means for causing interaction between the flow fronts of the first and second resin streams to form an interlocking knit line geometry.

5 9. The apparatus of claim 8 wherein means for causing interaction between the flow fronts of the first and second resin streams imparts at least one of: rotational and transverse flow to colliding resin streams.

10. The apparatus of claim 8 wherein the means for causing interaction between the flow fronts is at least one implement inserted within the mold cavity.

11. The apparatus of claim 10 wherein the at least one implement is one of: a molded paddle, directional vane and a directional dam.

12. The apparatus of claim 10 wherein the at least one implement is incorporated into the mold at a predetermined, desired location of knit line formation.

15 13. The apparatus of claim 11 wherein, where the at least one implement is the molded paddle, the molded paddle is rotated during the molding process to facilitate interaction of the flow fronts of the resin streams and is retracted from the mold cavity before molding is completed.

20 14. The apparatus of claim 11 wherein, where the at least one implement is the molded paddle, the molded paddle is rotated during the molding process to facilitate interaction of the flow fronts of the resin streams, is retained in the molded article and is bonded with the resin to provide increased strength.

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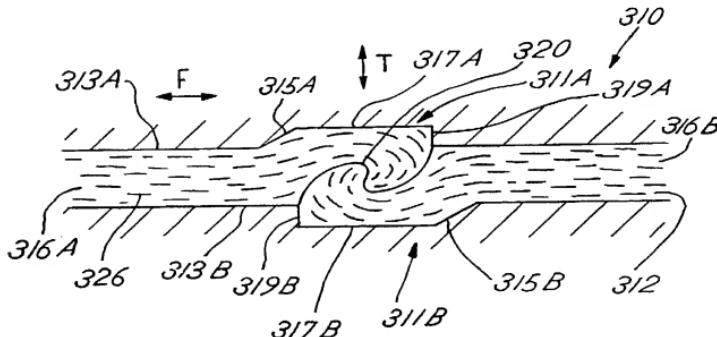
(75) Inventor/Applicant (for US only): PORTER, Marshall,

Published:

— With international search/report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

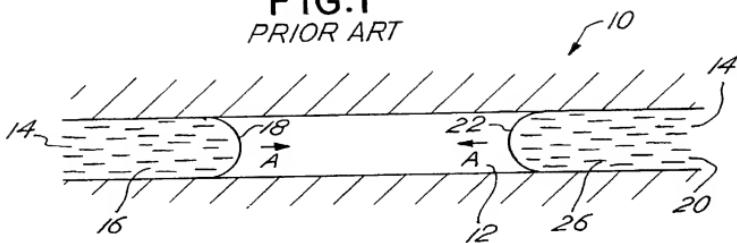
(54) Title: INJECTION MOLDING TECHNIQUES UTILIZING INTERLOCKING KNIT LINES



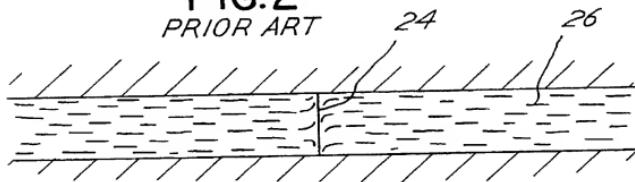
(57) Abstract: The present invention provides a process and apparatus for injection molding articles in which first (316A) and second (316B) resin streams within the mold cavity (312) interact to form an interlocking knit line geometry (320). The process includes the steps of: a) providing a mold defining a mold cavity; (b) providing first and second resin streams within the mold cavity, each resin stream having a flow front; and c) causing the flow fronts to interact to form an interlocking knit line geometry.

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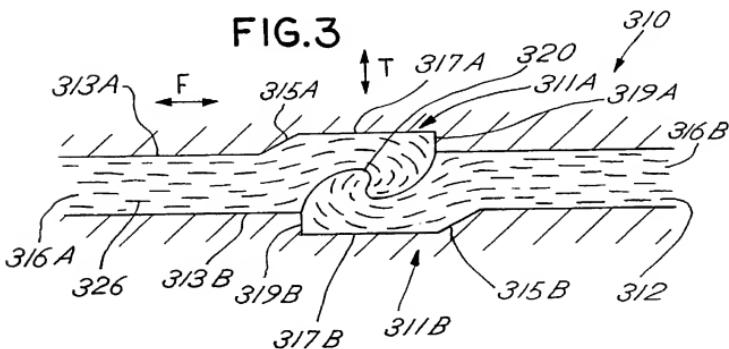
**FIG.1**  
PRIOR ART

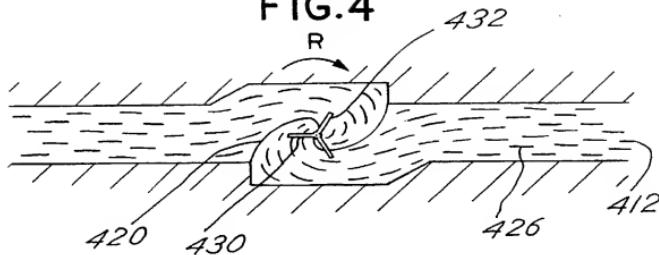
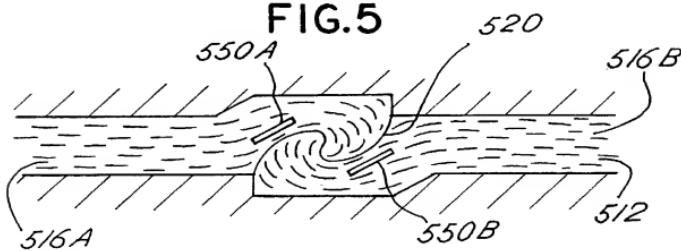
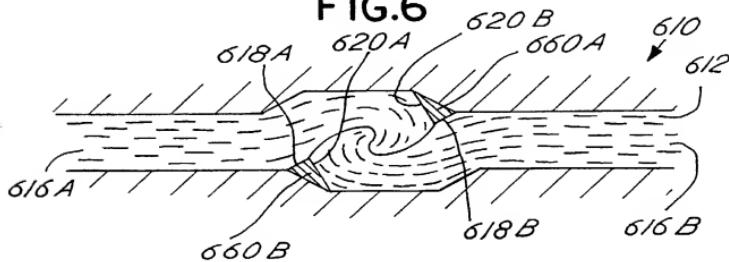


**FIG.2**  
PRIOR ART



**FIG.3**



**FIG.4****FIG.5****FIG.6**

Express Mail Label No.

Page 1 of 3

Docket No.  
03251.00002**Declaration and Power of Attorney For Patent Application****English Language Declaration**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**INJECTION MOLDING TECHNIQUES UTILIZING INTERLOCKING KNIT LINES**

the specification of which

(check one)

 Is attached hereto, was filed on October 3, 2000 as United States Application No. or PCT InternationalApplication Number PCT/US 00/27198

and was amended on \_\_\_\_\_

(If applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

## Prior Foreign Application(s)

## Priority Not Claimed

(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>

Page 2 of 3

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

60/157,733	October 5, 1999
(Application Serial No.)	(Filing Date)

(Application Serial No.)	(Filing Date)
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(Application Serial No.)	(Filing Date)
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I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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